

Kovar et al.
09/898,379
07/05/2001

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Examiner: Dzung D. Tran

Remarks

Claims 1-22 are in this case. Independent claims 1 and 19 have been amended to more clearly define the invention. Specifically claims 1 and 19 have been amended to define a single data modulator. Examples of support for this amendment can be found in paragraph [11] and in original claim 8. Dependent claims 13-15 and 21-22 have been amended to agree with the independent claims.

Claims 1-6, 8-17, and 19-22 are rejected under 35 USC 103(a) as unpatentable over Ross in view of Bergano. Applicant respectfully traverses this rejection.

The present invention discloses a simple and efficient method and device for encoding data at high data rates using alternate polarization interleaving to overcome problems of pulse broadening and jitter and eliminate non-linear interactions. This significantly improves the error rate. In a preferred embodiment, the present invention comprises a single data modulator, and a narrow band modulator for rotating and combining the polarization of alternate solitons at the data rate. In an alternate embodiment, a pulse train of half the data rate is provided to a polarization delay line that separates the pulse train into two orthogonal polarization states, delays one state by half the period, and recombines them as alternate orthogonally polarized pulses at the full data rate. A single data modulator operating at the data rate applies the data to the interleaved pulse train. Both embodiments are significantly less complex and costly than any teaching in the prior art.

Bergano recognizes the improved error rate that can be achieved through polarization multiplexing. However, the system taught by Bergano is difficult to realize. Bergano splits a pulse train at half the data rate into two streams of orthogonal polarizations. Polarization controllers or polarization maintaining fiber are employed to maintain the orthogonal polarization states through the device. The orthogonal streams are passed through two separate data modulators (205, 206) also operating at half the data rate. The RF signals to each of the modulators must be synchronized to each other and with the

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pulses. One of the streams is then delayed through a delay line by half the period before the two streams are recombined in a polarization combiner at the full data rate.

The use of two data modulators in the Bergano device is expensive and complex. Synchronization between the data modulators and the mode locked laser with sub-picosecond accuracy is not trivial. In addition, the RF data must be synchronized with the optical pulse trains, requiring at least one electrical delay line. A further problem of electrical cross talk occurs between the two modulators, particularly in an integrated device.

The system taught by Ross (US patent No. 3,956,626) is equally complex as the Bergano teaching. Furthermore, the purpose and structure taught by Ross are not similar to the purpose or structure of the present invention. Ross discloses an alternative coding scheme using less power than existing systems. Ross discloses a quaternary encoding system in which variables of time delay and polarization state are modulated to provide greater information per bit, and higher modulation efficiency. Alternate bits are not assigned orthogonal polarizations. Polarization is dependent on the data-coding scheme, and thus relatively random if considered for the purpose of preventing pulse overlap or interaction. The Ross system uses active components including synchronous polarizers, polarization rotators and a polarization modulator. In the present invention, polarization rotation and time delay for synchronization is accomplished with passive components. For example, only a passive spacer 176 is required to synchronize alternate pulses.

Similar to Bergano, Ross teaches the use of at least two and preferably three data modulators. Two of the modulators operate at half the data rate on separate synchronized streams that are then combined in a polarization combiner.

Looking more closely at claim 1 of the present invention as currently amended, Neither Ross nor Bergano discloses "a single data modulator". And Ross does not provide "a data stream of orthogonally polarized alternate light pulses". It is apparent that the invention cannot be obvious in view of the combination of Ross and Bergano. Such a

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combination could not suggest a single data modulator in a system that provides data encoding of a single pulse train to be transmitted at alternate orthogonal polarizations, while eliminating the problems of synchronization and polarization control.

Independent claim 16 as originally filed is also rejected in view of Ross and Bergano. Claim 16 defines a first, second and third Mach Zehnder device, the data modulator comprising the second Mach Zehnder. This is clearly a single data modulator as discussed with respect to claim 1 above. The third Mach Zehnder is for directing alternate pulses to integrated polarization rotation and interleaving elements. This simplified, integrated solution is not suggested by the prior art.

Independent method claim 19 has been similarly amended to recite, "providing a single pulse train ..." and "encoding data on the single pulse train ..." to define the simplified method obtained by the present invention. The teaching of Ross and Bergano does not suggest a simple and rapid solution as provided by the present invention. Rotating the polarization of alternate pulses at the data rate is not taught in the prior art.

Applicant submits that dependent claims 2-15, 17-18 and 20-22 are not obvious in view of Ross and Bergano as dependent on allowable independent claims.

Applicant notes with thanks the indication that claims 7 and 18 are allowable. In view of the amendments and remarks above, Applicant submits that all the claims are in condition for Allowance. Applicant respectfully requests reconsideration of this application.

Applicants request confirmation of consideration of the IDS filed with the application in the U.S. Patent and Trademark Office on July 5, 2001.

Should any minor informalities need to be addressed, the Examiner is encouraged to contact the undersigned attorney at the telephone number listed below.

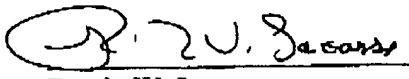
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Respectfully submitted,


Randy W. Lacasse
Reg. No: 34,368

2/2/05
Date:

1725 Duke Street
Suite 650
Alexandria, VA
USA, 22314

Tel: (703) 838-7683
Fax: (703) 838-7684

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